Swami Ramanand Teerth Marathwada University,
Nanded, Maharashtra, India

(UGC Recognized, NAAC Re-accredited 'B++' grade state university)

"Studies on Aquatic Insect Diversity and its Role in Lentic Ecosystems of Parbhani District"

Research Proposal Submitted to RRC Zoology
In partial fulfilment of Registration to

Ph. D. Programme
In the subject **Zoology**
under the faculty of **Science and Technology**

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August, 2023

Abstract of proposed work plan:

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Introduction:

Water is the most basic natural resource needed for the survival of all living organisms in this biosphere. It plays an essential role in the maintenance of human health and aquatic ecosystem. Aquatic macro invertebrates constitute an important component of an aquatic ecosystem and they exhibit differential tolerances to changes in environmental condition. They include insects, annelids (leeches), oligochaetes (worms), crustaceans (crayfish and shrimp), molluscs (clams and mussels), and gastropods (snails) (Adu, Kemabonta, & Giwa, 2016). Of all these groups of macro invertebrates, the number and diversity of aquatic insects are known to be 12 times greater than other animals that share the same habitat with them, including fish, amphibians and crustaceans (Montréal, 2017) . Insects are the most abundant of all life on earth and have evolved into a tremendous range of different forms. There are roughly 1 million described insect species (Zhang, 2011).

Aquatic insects are important component of benthic macro invertebrates who spend their life or some part of their life in water. Being highly specialized they represent less than 1% of the total animal diversity (Pennak, 1978). Of all the insect species to this globe, ~100,000 species spend at least one life stage in water (Dijkstra et al., 2014). They are known to play a very significant role in the processing and cycling of nutrients as they belong to several specialized feeding groups such as shredders, filter feeders, deposit collectors, and predators (Rosenberg and Resh, 1993). Such type of work has not done on some places, so that is why we take this topic.

Yeldari Dam area on the river Purna, situated at sawangi, Maharashtra, India (Latitude 19.7196664°N and Longitude 76.7319488°E). The height of the dam above its lowest foundation is 51.2 m (168 ft) while the length is 4,232 m (13885 ft). The live storage capacity is 0.81 km^3 (0.19 cu mi). Karpara dam situated at the river Niwali, Jintur, Dist. Parbhani, Maharashtra, India (Latitude 19.516726° and Longitude 76.628029°). The height of the dam above lowest foundation is 16.66 m (54.7 ft) while the length is 1.046 m (3.432 ft). The volume content is 344 km^3 (83 cu mi) and gross storage capacity is 27,320.00 km^3 (6,554.42 cu mi). During the study period this segment is featured by small and moderate perennial rocky

elevation with shore-line trees of semi-evergreen and evergreen vegetation. Cool and dusty green stagnant water is found flowing over eroded bedrock, cobbles and boulders. Mid-stream depth is below 1.0m making the segment wadable. Yeldari Dam, Karpara Dam will be segmented into five parts as per the sites viz. east end, west end, south end, north end and centre of the water reservoir for the water sampling.

Review of Literature and Development in the subject:

Hotaling et al., (2020) have investigated the aquatic insect diversity using genetic approach and explained that when compared to efforts for terrestrial insects, aquatic insects are dramatically underrepresented in genomic research. This underrepresentation is consistent for the total quantity of available genomes and their quality and is not due to any practical limitation (e.g., body size or genome complexity). Rather, it appears to simply reflect a lack of interest. We call for targeted efforts to generate more aquatic insect genomes, and particularly for highly contiguous (contig N50 > 1 Mbp), chromosome-level assemblies to be produced. By expanding the availability of aquatic insect genomes, insect and arthropod genome biology stands to gain considerable new potential for research at both the fundamental and applied scales.

Sundar S. et al., (2020) have investigated on the conservation of freshwater micro invertebrates diversity in the tropical regions and submitted reviews article explaining about recent global initiatives for biodiversity conservation and restoration, this article reviews the gaps in our understanding of, and the challenges facing, freshwater macro invertebrate biodiversity and conservation in tropical regions, study revealed a lack of adequate taxonomic, phylogenetic, and ecological information for most macro invertebrate groups, and consequently there are large scale knowledge gaps regarding the response of macro invertebrate diversity to potential climate change and other human impacts in tropical regions.

Adu and Oyeniyi, (2019) reported a research work regarding Water quality parameters and aquatic insect diversity in Aahoo stream, south-western Nigeria. The study revealed that Aahoo stream is somewhat polluted based on data on physico-chemical water quality and the entomofauna composition. This is evidenced by the collection of assemblages of chironomids in the stream which are tolerant to polluted water. Also, all Odonata taxa collected were the eurytopic types which could thrive in polluted water. Lestinogomphus (Gomphidae), an odonate associated with heavily polluted water, was also among the Odonata representatives

at the stream; although few organisms from this genus were sampled at the stream. To complement the biotic data, physico-chemical conditions of the stream also suggest that the stream is somewhat polluted.

Mandape and Kamdi, (2022) discussed about diversity of aquatic insect as a bio indicator with water quality parameters of selected Wainganga river basin areas of Pauni, district Bhandara, Maharashtra. A study was conducted on the diversity of aquatic insects in the area of Pauni which is the Kashi of Vidarbha (Latitude 20° 48' 17" and Longitude 79° 37' 51") is located in Maharashtra. In this study, a biomonitoring research programme of the basin areas of Pauni using entomological indicator of lotic ecosystem was taken place during January-2021 to December-2021. The current study revelated 25 species of aquatic insect belonging to 5 different orders were recorded. At order level highest species of Hemiptera (7) were recorded Similarly, Coleoptera (5), Odonata (6), Diptera (4), Ephemeroptera (3) aquatic insect species was found in basin water ecosystem. Different diversity indices were recorded out in all seasons.

Romero et al., (2021) wrote about Pervasive decline of subtropical aquatic insects over 20 years driven by water transparency, non-native fish and stoichiometric imbalance and said that insect abundance and diversity are declining worldwide. Although recent research found freshwater insect populations to be increasing in some regions, there is a critical lack of data from tropical and subtropical regions. Here, we examine a 20-year monitoring dataset of freshwater insects from a subtropical floodplain comprising a diverse suite of rivers, shallow lakes, channels and backwaters. We found a pervasive decline in abundance of all major insect orders (Odonata, Ephemeroptera, Trichoptera, Megaloptera, Coleoptera, Hemiptera and Diptera) and families, regardless of their functional role or body size. Similarly, Chironomidae species richness decreased over the same time period. The main drivers of this pervasive insect decline were increased concurrent invasions of non-native insectivorous fish, water transparency and changes to water stoichiometry (i.e. N : P ratios) over time. All these drivers represent human impacts caused by reservoir construction. This work sheds light on the importance of long-term studies for a deeper understanding of human-induced impacts on aquatic insects. We highlight that extended anthropogenic impact monitoring and mitigation actions are pivotal in maintaining freshwater ecosystem integrity.

Jähnig et al., (2020) submitted their opinion regarding revisiting global trends in freshwater insect biodiversity. Authors revealed a recent global meta-analysis reporting a decrease in terrestrial but increase in freshwater insect abundance and biomass. The authors suggested that water quality has been improving, thereby challenging recent reports

documenting drastic global declines in freshwater biodiversity. We raise two major concerns with the meta-analysis and suggest that these account for the discrepancy with the declines reported elsewhere. First, total abundance and biomass alone are poor indicators of the status of freshwater insect assemblages, and the observed differences may well have been driven by the replacement of sensitive species with tolerant ones. Second, many of the datasets poorly represent global trends and reflect responses to local conditions or non-random site selection. Authors concluded that the results of the meta-analysis should not be considered indicative of an overall improvement in the condition of freshwater ecosystems.

Chakrawarti and Gupta (2021) also investigated the aquatic insect diversity for monitoring the health of Jatinga river, North east India. A bio monitoring study of River Jatinga located in south Assam, north east India was conducted for the first time. The study aimed to evaluate water quality of the river in different stretches using aquatic insect as bio indicators. Insect samples were collected from selected sites of midstream and downstream of the river during monsoon- post monsoon, 2018 and winter- pre monsoon, 2019. A total of 25 families of aquatic insects recorded from 8 orders; Gerridae was dominant in midstream across all the seasons with highest percentage in winter. Hemiptera, the most diverse group was represented by six families with highest relative abundance. The study found that although both the sites were represented by same functional feeding groups, there were seasonal and spatial variations in the families of insects and their percentage occurrences. All the biotic indices, BMWPTHAI, SIGNAL2 scores, EPT % and HFBI have shown relatively better quality of water of the River Jatinga in the midstream than that in the downstream during monsoon and post monsoon seasons. Presence/absence and abundance of certain insect groups can provide information about health of the river.

Objectives of Research:

- Collection of the aquatic insects from the water reservoirs.
- To study inter-relation between water chemistry and diversity of aquatic insect.
- Macroscopic and microscopic characterization of the insects.
- Identification of the collected insects up to most possible level.
- Determining the variations in the diversity of the aquatic insects.
- To study the role of the insect diversity on the food chain of local ecosystems.
- Categorisation of aquatic insects as harmful or beneficial or neutral or bio indicator.

Methodology to be adopted:

Aquatic insects will be collected by using "kick-net method" and "all out search" methods from the midstream and downstream of Yeldari Dam and Karpara Dam during summer, monsoon and winter seasons of the year. Sampling will be done by taking three, 1-minute kick-net samples (mesh opening: 180µm; area $1m^2$). The kick-net will be held in the reservoir water and an area of ($1M^2$) in front of the net is disturbed for one minute (Brittain, 1974; Subramanian and Sivaramakrishnan, 2007). All out search method will be used when water flows through boulder and cobble with high turbulence during discharge of water through slope/ exit door of the dams. Aquatic insects will be collected from 10 square meter area for one hour in each segment of the water reservoir. Within the sampling area, aquatic insects will be searched in all the possible substrata such as boulders, cobbles, leaf litter and dead wood. A sable hairbrush or forceps will be used for collection of all samples (Subramanian and Sivaramakrishnan, 2007). After collection, insects will be preserved in 70% ethanol. Collected samples will be examined under a motic stereozoom microscope. Identification will be carry out by using standard keys and monographs given by Edmondson (1959) and APHA (1989). and will be identified upto highest possible level.

In the present study, aquatic ecosystems including natural and manmade water sources like rivers (Yeldari dam, Niwali or Karpara dam water reservoir), lakes, ponds, wells and farm ponds of the Parbhani district, Maharashtra, India will be considered for investigating the aquatic insects diversity by collecting insects using 'kick-net method' and "all out search method". Various water parameters viz., temperature, tranceparency, pH, TDS, TS, Hardness, chlorides, dissolved oxygen, free carbon dioxide, nutrients etc. will be carry out on monthly basis by using standard methods given by APHA (1989).

We may adopt any other standard methodology for sample collection and standard literature for the identification of recorded aquatic insects, as if required.

Importance of the Study:

Aquatic insects are an important part of the freshwater ecosystem. They are a major source of food for fish and other aquatic animals. They also help to break down organic matter and recycle nutrients in the water. Aquatic insects are also used as bio indicators of water quality.

The presence or absence of certain species of aquatic insects can be used to assess the health of a water body. The study of aquatic insect biodiversity is a growing field of research. As we learn more about these important organisms, we can better protect them and the freshwater ecosystems they depend on. Here are some specific examples of the importance of studying aquatic insect biodiversity: In India, the study of aquatic insect diversity has helped to identify a number of threatened and endangered species. These species are now being protected under conservation laws. The study of aquatic insect biodiversity is a valuable tool for understanding and protecting freshwater ecosystems. By studying these important organisms, we can better ensure the health of our planet's waters.

➢ International Status:

Aquatic insects comprise 10% of all insect diversity, can be found on every continent except Antarctica, and are key components of freshwater ecosystems (Scott Hotaling et al2020). There are roughly 1 million described insect species of these, ~100,000 species spend at least one life stage in water Inland waters cover less than 1% of the Earth's surface yet harbor 10% of all known animal species, of which 60% is composed of aquatic insects. This diversity today numbers close to 100,000 described species.

We estimate that over 70% of aquatic animal species, including most insects, have complex life cycles, providing great adaptability and the potential to disperse outside water. This potential to adjust and disperse, and to access opportunity and evade extinction, sets insects apart from less diverse life forms and separates the freshwater majority from better-studied minorities such as fish (Mayhew PJ. 2007).

Aquatic insects can be found in almost every type of aquatic habitat throughout the world counting lakes, heavy streams, seaside water, saline pool, groundwater, and even pools of unrefined petroleum leaking (Chainey, 2004). Though the total makeup of aquatic insects is between 3 to 5%, among all insect species (Abhijna et al., 2013), but their role is critical, as they serve as an indicator for the human impact, on aquatic ecosystem. Moreover, Aquatic insects are especially appropriate for use of environmental impact assessment and has long convention in checking the water quality, and provide a range of responses to disturbance influences at several levels by organisms (Bonada et al., 2006).

Aquatic insects are important component of benthic macro invertebrates who spend their life or some part of their life in water. Being highly specialized they represent less than 1% of the total animal diversity (Pennak, 1978). They are known to play a very significant role

in the processing and cycling of nutrients as they belong to several specialized feeding groups such as shredders, filter feeders, deposit collectors, and predators (Rosenberg and Resh, 1993). Some of the aquatic insects are very sensitive to pollution, while others are tolerant and many species are very susceptible to pollution or alteration of their habitat (Merritt and Cummins, 1996).

➢ National Status:

India is a country with a rich diversity of freshwater aquatic insects. The country is home to over 10,000 species of aquatic insects, belonging to 12 different orders (Dijkstra et al., 2014). These 12 orders of aquatic insects found in India are: Ephemeroptera (mayflies), Odonata (dragonflies and damselflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Megaloptera (alderflies and dobsonflies), Hemiptera (true bugs), Diptera (flies), Coleoptera (beetles), Hymenoptera (ants, bees, and wasps), Lepidoptera (butterflies and moths), Neuroptera (lacewings and antlions), Orthoptera (grasshoppers and crickets). Five insect orders are almost exclusively aquatic—requiring freshwater for their entire larval development—and include more than 27,000 species: Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Odonata (dragonflies and damselflies), and Megaloptera (alderflies, dobsonflies, and fishflies) (Balian et al., 2008). These insects play an important role in the freshwater ecosystem, as they are a major source of food for fish and other aquatic animals. They also help to break down organic matter and recycle nutrients in the water. The diversity of aquatic insects in India is influenced by a number of factors, including climate, altitude, and habitat type. The highest diversity of aquatic insects is found in the Himalayas, where the cool, clear waters provide ideal conditions for these insects. Other areas with high diversity of aquatic insects include the Western Ghats, the Deccan Plateau, and the north-eastern states of India. The distribution of aquatic insects in India is determined by the availability of suitable habitats. These insects are most commonly found in rivers, streams, lakes, ponds, and wetlands. They can also be found in temporary water bodies, such as rainwater puddles (Zhang, 2011).

➢ Significance of study:

- Food source: Aquatic insects are a major food source for fish, amphibians, reptiles, birds, and mammals.
- Decomposers: Aquatic insects help to break down organic matter in the water, which helps to keep the water clean and healthy.

- Indicators of water quality: The presence or absence of certain species of aquatic insects can be used to assess the health of a water body.
- Biodiversity: Aquatic insects are a diverse group of organisms, and their diversity is important for the overall health of the freshwater ecosystem.
- To understand the role of aquatic insects in freshwater ecosystems: By studying the diversity of aquatic insects, we can better understand their role in the food web, nutrient cycling, and water quality.
- To identify and conserve threatened and endangered species: Many species of aquatic insects are threatened or endangered. By studying their distribution and ecology, we can better understand the threats they face and develop conservation strategies.
- To develop bio monitoring tools: Aquatic insects can be used as bio indicators of water quality. By studying the diversity of aquatic insects in a water body, we can assess the health of that water body.

The study of aquatic insect biodiversity is a growing field of research. As we learn more about these important organisms, we can better protect them and the freshwater ecosystems they depend on. Here are some specific examples of the importance of studying aquatic insect biodiversity: In India, the study of aquatic insect diversity has helped to identify a number of threatened and endangered species. These species are now being protected under conservation laws. The study of aquatic insect biodiversity is a valuable tool for understanding and protecting freshwater ecosystems. By studying these important organisms, we can better ensure the health of our planet's waters.

Threats to Aquatic Insect Diversity:

The diversity of aquatic insects in India is threatened by a number of factors, including:

- Habitat loss and fragmentation
- Pollution
- Climate change
- Invasive species

Conservation of Aquatic Insect Diversity:

The conservation of aquatic insect diversity is important for the health of the freshwater ecosystem. There are a number of things that can be done to conserve aquatic insect diversity, including:

- Protecting and restoring freshwater habitats
- Reducing pollution

- Managing invasive species
- Educating the public about the importance of aquatic insects.

Proposed Work Plan:

➢ Year-wise Work plan:

Time Period	Work Plan
Year One (0 to 6 months)	Course work examination
Year One (7 to 12 months)	Review of Literature
Year Two (0 to 6 months)	Collection of the aquatic insects & analysis of water parameter
Year Two (7 to 12 months)	Collection of the aquatic insects & analysis of water parameter
Year Three (0 to 6 months)	Characterization and identification of the insects
Year Three (7 to12 months)	Determination the role of insect on nearby ecosystems
Year Four (0 to 6 months)	Data compilation and rearrangement
Year Four (7 to 12 months)	Thesis writing and submission to the University
Year Five (0 to 6 months)	Final Viva-voce

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